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(54) FROZEN PRODUCT MACHINE

(71) We, FMC CORPORATION, a corporation organized and existing under the laws of the State of Delaware, United States of America, of 1105 Coleman Avenue, San Jose, State of California, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to continuous freezing machines, and more particularly to an automatic machine for the continuous production of frozen slabs of liquid or semi-liquid food products, such as egg whites, egg yokes, or mixtures thereof, ice cream etc.

According to the present invention there is provided a continuous freezing machine comprising upwardly-open moulds extending across an elongate frame, a mould conveyor mounted on said frame for moving each said mould, an extractor pin removably positioned in each lateral end portion of said mould, said extractor pins having no mechanical bridging connection, means for filling the mould with a product which is subsequently frozen on to said extractor pins, conjointly operable frozen slab-withdrawal means for individually gripping and elevating said extractor pins to remove successively formed slabs from the mould at a defrost station, slab-release means for operating said pins to release the frozen slab from said pins at a discharge station, pin return means for returning the slab-free extractor pins at a pin return station for movement with the conveyor, and slab-catching means underlying said discharge and pin return stations.

Further according to the present invention there is provided a frozen product machine comprising a frame, open-top moulds, conveyor means on said frame for incrementally carrying said moulds through a plurality of processing stations, at least two rotatable extractor pins removably positioned within the space defined by each said mould, means for filling the moulds with material to be frozen into a slab on said extractor pins and subsequently withdrawn from the mould, a portion of each of said extractor pins which lies within the moulds including a half-round shank having a flat longitudinal face, and an oppositely disposed transversely arcuate longitudinal face, said flat face in an unrotated position of said extractor pin being in abutting relation with one inner wall of each said mould so that said arcuate face is eventually freeze-bonded to the product slab and the flat face is substantially coplanar with the adjacent outer surface of the slab, and means for rotating said extractor pin substantially through 180 degrees about an axis coincident with said flat face subsequent to freezing of the product slab and its removal from the mould, said rotation thereby reversing the former orientation of said extractor pin relative to the slab so that the frozen bond is destroyed and the extractor pin surfaces are disposed laterally clear of the slab.

Still further according to the present invention there is provided a continuous freezing machine including a plurality of open top moulds movable through a brine tank to freeze product in the moulds, two extractor pins removably positioned in each mould, each said extractor pin including a gripping head positioned above the open top of the mould and a shank portion lying within the mould, a vertically-reciprocable transfer yoke intermittently positioned in an initial plane of movement of said gripping head, said transfer yoke and said gripping head being arranged to interlock slidably at a defrosting station for subsequent coextensive vertical movement of said transfer yoke and said extractor pins, means operative to defrost the frozen bond between a frozen product slab and the mould at a defrosting station, means for moving said transfer yoke upwards to a predetermined plane superposed above said defrosting station with the frozen product engaged with said extractor pins, a horizontally-reciprocable pusher bar movable through driving and return strokes in the elevated plane of said gripping head, and power means for coextensively moving said pusher bar in a driving stroke in the same downstream direction with each powered movement of

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said conveyor, said extractor pins and the frozen product bar carried by said extractor pins thereby being ejected downstream from said yoke in vertically aligned and elevated relation with said moulds, and support means for the thus ejected gripping head.

An embodiment of a frozen product producing machine in accordance with the invention, will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a side elevation, partly broken away, of the frozen product machine in accordance with the present invention;

Figures 2-5 are fragmentary diagramatic perspective views illustrating successive operational steps in the moulding, thawing and removal of a frozen product slab;

Figure 6 is fragmentary elevation to an enlarged scale, of mechanism concealed by the herein broken away near side plate at the left-hand portion of Figure 1;

Figure 7 is a transverse section, to an enlarged scale, line 7-7 of Figure 6;

Figure 8 is a fragmentary perspective view, to an enlarged scale, of part of the mechanism at the left-hand end of Figure 7;

Figure 9 and 10 illustrate the same area covered by Figure 8 but in progressively more complete stages of assembly;

Figures 11-16 are diagrammatic longitudinal sections on line 11-11 on Figure 7, and illustrate one complete cycle of six successive operational steps;

Figures 17-22 diagrammatically illustrate a pneumatic control circuit and six sequential steps that respectively correspond to the steps illustrated in Figures 11-16;

Figure 23 is a timing section diagram, the vertical divisions of which correspond to the six operational steps shown in Figures 11-22;

Figure 24 is a fragmentary plan, to an enlarged scale, of a mechanism which prevents upward movement of a mould while the frozen product slab in the mould is extracted; and

Figure 25 is a section on line 25-25 of Figure 24.

The frozen product machine 20 (Fig. 1) embodies some of the same general machine components disclosed in the patent application No. 50704/67 (Serial No. 1,174,188) and in patent specification No. 918,592. Freezing machines proposed in these specifications operate by intermittently conveying a plurality of moulds successively through stations at which a filling mechanism places product in the moulds, a freezing tank freezes the product in the moulds, defrosting means thaw the exterior of the frozen product to the extent that it can be removed from the mould, and washing and sterilizing apparatus prepare the moulds for another filling cycle.

Briefly, and with reference to Figure 1, the frozen product machine 20 includes a frame 22 which supports a pair of intermittently driven drive sprockets 24 and a pair of idler sprockets 26, only one of each being shown. The drive sprockets are mounted on a common shaft 25 and one of the sprockets is driven by an air cylinder 27 having a piston rod 31 that reciprocates a ratchet mechanism 29 in the same manner as disclosed in patent application 50704/67 (Serial No. 1,174,188). An endless conveyor chain 28 extends longitudinally through the machine around each aligned pair of sprockets to form a mould conveyor A, and laterally extending open-top moulds B are secured to and carried by the chains. For controlling automatic operation of the conveyor A and associated apparatus in a manner described hereinafter, a rearward extension of the piston rod 31 carries a valve actuator bar 33 which in one position actuates two pilot valves P4 and P5, and in another position actuates a pilot valve P3.

The upper reach of the chain extends under a mould filler 30 that automatically fills each mould with the product to be frozen, such as shelled fresh eggs, for example. Each mould carries an extractor mechanism comprising a pair of removable extractor pins C that are frozen into the product and support the frozen product slab E when it is removed from the mould. After filling, the moulds proceed through an insulated brine tank 32 in which the liquid, at sub-freezing temperature, surrounds the moulds and freezes the product both to the mould and to the extractor pins C carried within the mould.

Following intermittent movement across ascending portions of the upper chain reach, each mould comes to rest at a defrost station D where the frozen bond between the mould and the product is loosened. At this same station the extractor pins C are gripped and moved upward after the frozen bond is defrosted. The frozen product slab E is now in an elevated position above the moulds. In this elevated position, the slab is carried horizontally by the extractor pins C as the pins are driven in increments of movement synchronized with the movements of the mould conveyor A. At a discharge station F the extractor pins C are mechanically manipulated to release the slab E for removal from the machine by a discharge conveyor DC and a chute at 34, and subsequent wrapping and packaging. The empty extractor pins C then advance to an EXTRACTOR RETURN STATION G where the extractors are lowered back into one of the moulds on the conveyor A. During return toward the mould filler 30 on the lower reach of the mould conveyor A, the moulds and the extractor pins therein are successively cleaned at a washing station H, rendered

sterile at a sterilizing station J, and then moved under the mould filler 30 to be refilled for another freezing cycle.

The present invention specifically concerns the extractor pins C and the mechanism associated with the defrost station D, discharge station F and the extractor return station G. Thus, the elements D, F and G collectively form a slab handling zone K which will be presently described in detail. First, however, it will facilitate an understanding of the basic structural details to briefly consider the selected operational procedures diagrammatically illustrated in Figures 2-5 for one of a pair of the extractor pins C.

The mould B (Fig. 2) carries an extractor pin C at each end, and includes an upper flange or ledge 36 which is supported by a chain attachment link 38 of the adjacent upper reach of the conveyor chain 28. Each chain reach is supported by fixed, linear track runs 40 which are engaged by integral rollers 42 of the chains 28. The attachment link 38 is provided with two upstanding studs 44 which project through corresponding apertures, not shown, in the ledge 36 so that the mould B is removably mounted on the conveyor chain 28 for replacement or repair. Also removably mounted in similar manner on the pair of studs 44 is an extractor support and locking plate 46. When the mould B is carried through the brine tank 32, and through other portions of the machine, except at the DEFROST STATION D and at the EXTRACTOR PIN RETURN STATION G, the extractor pin C and the mould B are prevented from upward movement by a fixed hold-down rod 48 that is closely spaced from the extractor support plate 46.

Secured to the extractor support plate 46 is an extractor pin C which has a round portion 51 with an axis of rotation 52 and a half-round shank 54 below the plate 46. The flat side 56 of the shank is coincident with the axis of rotation 52, and contacts the inner surface of the adjacent side wall 58 of the mould B. A semi-circular disc portion 60 is formed about the same axis 52 and has a larger radius than the half-round shank 54 so as to form an inwardly projecting ledge 62 that is eventually frozen to the product in the mould. The upper end of the extractor pin C is provided with a square gripping block or head 64 that is symmetrical about the axis 52.

The initially liquid product at 66 (Fig. 2) becomes frozen into the slab E as the mould progresses step by step through the brine tank 32 (Fig. 1). At the DEFROST STATION D, the gripping block 64 slides into a power-actuated transfer yoke 68 (Fig. 3), and while the mould B (Fig. 3) dwells, a defrosting tank 69 containing hot water is automatically elevated into surrounding relation with the mould to defrost the frozen bond between the slab E and the mould surfaces. The transfer yoke 68 is driven upward after a predetermined dwell of the defrosting tank in its up position to loosen the frozen bond between the frozen slab E and the mould B. A holding mechanism illustrated in Figures 24 and 25 locks the mould B from vertical movement when the slab is extracted.

When the slab E and extractor pin C attain a predetermined elevation above the thus emptied mould, the gripping block 64 is moved downstream out of the transfer yoke 68. The frozen slab remains supported by the extractor pin C, as shown in Figure 4, because the extractor pin ledge 62 extends inwardly into the slab. After several increments of movement, the gripping block 64 slides into a twisting yoke, later shown and described, which is similar to the transfer yoke 68 but is arranged to be rotated 180 degrees about a vertical axis coincident with the axis 52 of the extractor pin C.

This rotation of the extractor thus causes the half-round shank 54 and the semi-circular disc 60 to lie wholly outside the end face 70 (Fig. 5) of the slab E, and the frozen slab drops by gravity from the extractor pin C for removal from the machine, followed by wrapping, packaging and delivery or storage. The released slab has only a small cavity 71 which was formerly occupied by the disc and shank. The extractor is then rotated back to its initial position and transferred into a return yoke which is later described and shown. The return yoke moves the extractor pin vertically downward and replaces the extractor pin in one of the moulds B. During return to the mould filler 30, the inverted moulds and extractors are thoroughly washed, drained and sterilized before the moulds are refilled for another freezing cycle.

Even though the surfaces of the extractor pin C in the initial, unrotated position may be completely freed from the frozen slab E when the bond between the slab and the mould is defrosted, the slab cannot fall because the disc ledge 62 provides a positive supporting interlock with the slab. It is thus of no consequence that there may be no frozen bond between the extractor pin C and the slab E following the mould defrosting operation.

With more specific and detailed reference to the drawings, Figures 6 and 7 illustrate the overall slab handling zone K, and Figures 8, 9 and 10 illustrate structure which is associated with only one side of the machine, but is essentially the same as the structure at the other side of the machine. Similar parts at the other side of the machine also appear in various drawings with the same reference numerals and the suffix "*a*". Extending upward from the machine frame 22 (Figs. 6 and 7) at the sides of the slab handling zone K are side plates 72 and 72*a* which

respectively carry machined mounting plates 74 and 74*a*. Vertically reciprocable between the two plates 74 and 74*a* is a transfer frame 80 which effects the vertical removal of the slab from the mould via the extractor pins C which carry the slab, and in conjunction with other mechanism, returns each pair of pins to one of the moulds after the frozen product slab has been removed.

The transfer frame 80 includes a transverse extractor bar 82 which, adjacent each end, carries one of the transfer yokes 68, as shown for only one side of the machine in Figure 8. Extending forward from the ends of the bar 82 are plates 84 and 84*a* (Figs. 7 and 8) carrying transverse stub bars 86 and 86*a*. The stub bar 86 carries a return yoke 88, as previously mentioned, at the EXTRACTOR RETURN STATION G (Fig. 6), and a bolt 89 which is arranged to actuate a pilot valve P7 when the transfer frame 80 is in its uppermost position. A bolt 91 on the underside of the transfer frame is arranged to actuate a pilot valve P1 when the transfer frame is in its lowermost position. A similar return yoke 88*a* is mounted on the stub bar 86*a*. The yokes 68 and 88 define longitudinally open and aligned generally T-shaped apertures 90 which are arranged to slidably receive the gripping head 64 of an extractor C. The yoke 88*a* and its unillustrated companion yoke (68*a*) are similarly apertured.

Intermediate the DEFROST STATION D. and the EXTRACTOR RETURN STATION G, the slab handling zone K (Fig. 10) includes the previously mentioned pair of twisting yokes 92 and 92*a* which are mounted at a fixed elevation at the DISCHARGE STATION F. The twisting yokes 92 and 92*a* define downwardly open vertical slots 94 and 94*a*, and are arranged so that solid body portions straddle the gripping heads 64 of a pair of extractors C when the twisting yokes are in the Figure 7 position. Subsequently, the twisting yokes 92 and 92*a* are rotated 180 degrees about a vertical axis to free the frozen slab, and then rotated back to their initial positions for transfer into the return yokes 88 and 88*a* when the transfer frame 80 elevates the return yokes.

Returning to Figure 8, plate 84 of the transfer frame 80 is provided with a forward guide block 100 which slidably engages a fixed, vertical guide bar 102. The other end of the plate 84 is provided with a similar guide block 104 which is anchored to the lower end portion of a gear rack 106 and slides in a vertical way which is defined by the mounting plate 74, a support bar 107, a guide bar 108, and cover plates 110 and 112. Above the guide bar 108, the upper portion of the rack 106 is guided and backed up by a slide plate having a land 114 which fits in a complementary groove in the rack to maintain meshing engagement of the rack with a pinion gear 116.

The pinion gear 116 is mounted on an equalizer shaft 118 having a similar gear 116*a* (Fig. 6) at the other side of the machine that is engaged with a similar rack 106*a*. A slab extracting air cylinder 120 (Fig. 8) has a piston rod 122 coupled to a clevis bracket 124 that is welded to the lower end of the rack 106. The interconnected racks 106, 106*a* and pinions 116, 116*a* assure simultaneous movement of each side of the transfer frame 80 when the slab extracting cylinder 120 is energized to vertically move the transfer frame 80. The holding mechanism previously mentioned, for allowing removal of the frozen slab and extractor pins while immobilizing the mould, is shown in Figures 24 and 25 for only one end portion of the mould. A pair of spaced holding straps 125 are bolted to the adjacent chain track and extend inward over the path of an incoming mould B. Confronting tab portions 126 of the straps 125 lie above the mould flanges 36 when the mould is indexed with the DEFROSTING STATION D, and the straps are vertically offset at 127 to clear the studs 44 when the mould is moved into defrosting position. Thus, when the transfer frame 80 is elevated to raise the transfer yoke 68, the mould B is held down by the holding straps 125, but the extractor pin C is not restrained.

The defrosting tank 69 (Fig. 6) is constructed and vertically reciprocated in the conventional manner disclosed in the aforementioned patent specifications. Thus, the tank 69 is mounted on a cross bar 130 that extends through an aperture 132*a* in the side plate 72*a* at the left side of the machine. Mounted on the outside of the side plate 72*a* (Fig. 7) is a slab defrosting air cylinder 134, the depending piston rod 136 of which is secured to the cross bar 130 as shown in Figure 6. Connected to the same end of the cross bar is a shaft 138*a* which is aligned with, and connected to, a superposed rack 140*a*. A similar rack and shaft 140 and 138 (Fig. 8) are connected to the other end portion of the cross bar 130. One end of the cross bar 130 has a valve actuator 139 (broken lines) which, when the piston rod 136 is retracted to elevate the defrosting tank, actuates a pilot valve P6 that is a component of the later described control circuit.

The gear racks 140, 140*a*, and a pair of pinion gears 144, 144*a* which are interconnected by an equalizer shaft 146, assure coextensive movement of each end of the defrosting tank 69 when the slab defrosting cylinder 134 is energized. As shown in Figure 8, the cover plate 112, the adjacent surface of the guide bar 108, a support plate 148, and a guide block 150 mount the rack 140 in a

manner similar to the mounting of the rack 106.

When the transfer frame 80 (Figs. 7 and 9) elevates a pair of the extractors C to the position shown in Figure 7, a horizontally reciprocable pusher frame 160 is actuated to push the extractors C out of the transfer yokes 68. The extent of such movement is equal to the intermittent movement of the moulds B on the conveyor A.

The pusher frame 160 includes a tie bar 162 which interconnects the Figure 9 structure with similar parts shown in Figures 6 and 7 at the other side of the machine. The tie bar 162 carries a valve actuator bolt 163 (Figs. 6 and 10) that is arranged to actuate an air valve P2 when the pusher frame 160 is in its fully retracted position. Depending from the tie bar 162 (Figs. 6 and 9) are L-shaped brackets 164 and 164a. The bracket 164 has a longitudinally extending pusher bar 166 that is aligned with the aperture 90 in the transfer yoke 68 when the yoke is elevated by the transfer frame 80. The bracket 164*a* has a similar pusher bar, not shown, cooperating with the other transfer yoke.

When the pusher frame 160 moves downstream with the pusher bars aligned with the yokes, the extractor pins are moved out of the yokes by the pusher bars of brackets 164 and 164*a*, and onto associated two-piece elevated guide tracks 170 and 170*a* (Figs. 7 and 9) that will be presently described.

The tie bar 162 (Fig. 9) is connected to an arm 172 which is bolted to a rack 174. Rack 174 has a grooved undersurface and is slidable on a complementary guide rib 176 that is supported and secured to a fixed shelf 178 which projects from the mounting plate 74. Rack 174 is meshed with a pinion gear 180 that is fixed on a rotatable equalizer shaft 182. The pinion gear 180a (Figs. 6 and 7) at the other side of the machine is mounted near a slab indexing air cylinder 190 which is pivoted to the side plate 72*a*. The piston rod 194 of the slab indexing cylinder is coupled by a link 196 to the equalizer shaft 182. When the cylinder 190 is energized to project its piston rod from the position shown in Figure 6, the pinion gears 180 and 180*a* rotate clockwise and drive the pusher frame 160 downstream a distance equal to the indexing movement of the moulds B. As shown in Figures 6 and 7, the rack 174*a* has a projecting bolt (not shown) which is arranged to actuate a pilot valve P8 when the pusher frame 160 is in its downstream position.

The pusher frame 160 (Fig. 9) includes a pair of inwardly projecting shafts 200 secured to the arm 172 and having reduced-diameter end portions 201. The end portions extend loosely through vertically elongate slots in an upwardly displaceable gravity-return pawl 202 which functions to advance and lock the extractor pins each time the pusher frame 160 is moved downstream. Thus, the pawl 202 is provided with driving ledges 203, 204 and 205 that are arranged to engage and push the gripping head 64 of an extractor pin, and which are spaced from one another a distance equal to the stroke of the pusher frame 160 and to the spacing between the moulds B. An inclined camming surface 206 adjacent each driving ledge cams the pawl 202 upward when it is returned over the extractor pin gripping head 64 to its Figure 9 position after a driving stroke. Meanwhile, the extractor pin gripping head is supported by the guide track 170. The two stations intermediate station D and station F are necessary for space requirements and correspond to the positions in which the driving ledges 203 and 204 place an extractor pin.

The guide track 170 is formed of two separate members which have confronting edges spaced apart to cooperatively define a slot which permits free sliding movement of the shank of the extractor pin but prevents lateral tilting of the pin. Further, the confronting edges of members 208 and 209 are relieved so as to form coplanar horizontal support surfaces, and vertical, parallel guide surfaces at 210 to support and guide the gripping head of the extractor pin. Near the end of the thus formed guideway, the tracks 170 are provided with confronting arcuate recesses which cooperatively define the diametrically opposite parts of a circular recess that provides a clearance aperture 212 for receiving the twisting yoke 92.

Means for supporting the upstream ends of the tracks 170 (Fig. 9) include a horizontal shaft 214 that projects from the mounting plate 74 and is connected to the near track. The other track is suspended by a link 216 from an overhead tie beam 218 (Fig. 7) that interconnects the side plates 72 and 72*a*. Support for the other ends of the tracks 170 includes a tie beam 220 extending between the mounting plates 74 and 74*a*, and angle brackets 222 which depend from the beam 220 and are bolted to the tracks.

Referring now to Figures 10, the twisting yoke 92 is rotatably mounted in axially fixed position in the tie beam 220, and is provided with a bevel gear 224. A bearing block 226, mounted between the tie beam 220 and a similar tie beam 228 (Fig. 7), rotatably mounts a transverse equalizer shaft 230 having a bevel gear 232 meshed with the gear 224. A link and collar 234 are secured to the adjacent end portion of the shaft 230 and coupled to the piston rod 236 of a slab releasing cylinder 238 (Fig. 6). When the cylinder 238 is energized to project its piston rod, the gear train rotates the twisting yoke 92 counterclockwise 180 degrees, and the shaft 230 and bevel gears 224*a* and 232*a* (Fig. 7) rotate the twisting yoke 92*a* 180 degrees

in the opposite direction. This described movement causes the extractor pins C to free the frozen slab E in the manner mentioned hereinbefore, whereby the slab drops onto the takeaway conveyor 34.

At a point in the operating cycle when the transfer frame 80 (Fig. 9) is fully elevated, the return yoke 88 is horizontally aligned with the elevated tracks 170, the twisting yoke 92 (Fig. 10) is in the position illustrated, and the pusher frame 160 is in its downstream position. Accordingly, the driving ledge 205 on the pawl 202 has forced the extractor C, which was formerly held in the twisting yoke, downstream into the T-shaped aperture 90 of the return yoke 88.

When the transfer frame 80 is subsequently lowered to the position shown in Figures 8-10, the extractor pins C, as shown in Figure 7, are replaced in one of the moulds B. Because the slab E has been released from the extractor pins C before the extractor pins are moved into the return yokes 88 and 88*a* (Fig. 7), it is necessary to mechanically stabilize the pins so as to inhibit their tendency to tip due to their unbalance, and thereby assure that the pins are accurately aligned for return to the mould. Accordingly, the return yoke 88 (Fig. 10) is provided with a spring-urged ball detent 240 which bears downward on the gripping head 64 of an extractor pin to keep the extractor pin vertical and inhibit relative movement between the head 64 and the yoke 88 until the extractor pin has been returned to the mould.

The extractor pins are moved toward the mould in their initial positions in which they were moved into the slab handling zone K, and are positioned as illustrated in Figure 2 after being returned to the mould. Thus, the extractor support plate 46 is positioned on the studs 44 so that the next indexing movement of the mould conveyor chains 28 will carry the gripping heads 64 of the extractor pins out of the return yokes 88 and 88*a*.

Figures 11-16 diagrammatically illustrate successive operational steps of the mechanism associated with the slab handling zone K, and Figures 17-22 schematically illustrate sequential stages of operation of an automatic control circuit incorporating the pilot valves P1-P8 which govern the various air cylinders that power the machine. The ensuing description covers both the control circuit and the mechanism thereby controlled as the moulds and frozen product slabs are automatically manipulated through the slab handling zone K, and are outlined as steps 1-6 which correspond to the steps labeled on the vertical columns of the timing diagram, Figure 23.

It should here be noted that one complete operating cycle will include four indexing movements of the mould conveyor A. This will result in one pair of the extractor pins being moved from one mould B on the mould conveyor A, through the slab handling zone K, and returned to another mould B on the mould conveyor A. Each indexing movement of the mould conveyor corresponds to the six steps illustrated in Figures 11-16. To avoid duplication of Figures showing intermediate steps which are conveying movements necessitated by timing considerations, an extractor pin C1 is illustrated in full lines through only part of a complete operating cycle, and its subsequent movements, minus the intermediate steps are illustrated by a phantom line extractor pin C1. Except where later noted, the ensuing description concerns the full line extractor C1.

STEP I (Figures 11 and 17)

The frozen product machine 20 is placed in operation by supplying air under pressure to an air input conduit 248, and by pulling the actuator of an ON-OFF air valve V. Assuming that the machine has previously been operated, as in the production run of a previous day, the positions of the various air cylinders might be as follows: The slab releasing cylinder 238 is at the end of a dwell period with its piston rod 236 retracted; the slab defrosting cylinder 134 is at dwell with its piston rod 136 advanced; the slab extracting cylinder 120 is at the beginning of a dwell period with its piston rod 122 retracted; the slab-indexing cylinder 190 is at dwell with its piston rod 194 extracted; and the conveyor indexing cylinder 27 is at the end of a dwell period with its piston rod 31 retracted. Correspondingly, the twisting yoke 92 will next begin to rotate; the defrosting tank 69 is at its lowermost position; the transfer frame 80 is in its lowermost position; the pusher frame 160 is in its upstream position; and the main conveyor A will next be indexed by the conveyor indexing cylinder 27.

When the valve V is "ON", a straight passage in the valve is aligned with a conduit 252 that is connected to the pilot valve P1 for the slab extracting cylinder 120. Because the piston rod 122 of the cylinder 120 is retracted, the straight passage in the valve P1 is in communication with a conduit 254. The air thus supplied to an air-operated, spring-return slave valve V1 shifts the core of the valve to place a straight passage in communication with the air input line 248 and a conduit 262 which leads to the slab releasing cylinder 238. The piston rod 236 is thereby projected, and the twisting yoke 92 (Fig. 11) begins to rotate.

At the same time, the retracted piston rods 194 and 31 of the slab indexing cylinder 190 and the conveyor indexing cylinder 27 have mechanically positioned the straight passages in their respective pilot valves P2 and P3 to transmit air through a conduit 266 to an

air-operated slave valve V2. A diagonal passage of the valve V2 thus transmits air through a conduit 270 into the piston rod end of the slab extracting cylinder 120 to assure that the transfer frame 80 is completely down before the main conveyor A is indexed by the conveyor indexing cylinder 27.

It will be noted that if the piston rod 122 of the slab extracting cylinder 120 is not fully retracted, the pilot valve P1 will not permit energization of the slab releasing cylinder 238 until the piston rod 122 of the slab extracting cylinder 120 is fully retracted to actuate the pilot valve P1. Similarly, the pilot valve must be actuated before air is fed from the conduit 254 into a conduit 272 that is connected to the conduit 254. The conduit 272 supplies pilot pressure to shift the core of an air-operated slave valve V3. As a safety measure, this assures that a diagonal passage of the slave valve V3 cannot admit air into a conduit 276 to project the piston rod 31 of the conveyor indexing cylinder 27 and index the main conveyor A, until the piston rod 122 of the slab extracting cylinder 120 is fully retracted.

As thus far described, the twisting yoke 92 (Fig. 11) begins to rotate, the transfer frame 80 is moved to its maximum down position (if not already down) so that the transfer yoke 68 can be slidably engaged by an extractor pin, and the conveyor A begins one indexing movement that will carry the moulds B downstream a distance equal to the center to center spacing of the moulds and place the gripping head 64 of the extractor pin C1 in the transfer yoke 68.

It will be seen that one diagonal passage of an air-operated slave valve V4 is interposed in a conduit 280 to transmit air from the input conduit 248 behind the piston of the slab defrosting cylinder 134 in order to maintain the defrosting tank 70 in its down position. Similarly, an air-operated slave valve V5, which is associated with the slab indexing cylinder 190, transmits air through a conduit 284 to retract the piston rod 194 of the slab indexing cylinder so that the pusher frame 160 is maintained in its rearward or upstream position.

STEP 2 (Figures 12 and 18)

When the conveyor indexing cylinder 27 has its piston rod 31 fully extended after completion of the above initiated driving stroke, the pilot valves P4 and P5 are actuated, and the first mould B1 with an extractor pin C1 is moved to the DEFROST STATION D so that the gripping head 64 of the extractor pin C1 slides into the transfer yoke 68 of the transfer frame 80. In actual operation, all of the moulds carry extractor pins C, but as illustrated in Figures 11-16 the extractor pins downstream of the pin C have been omitted for clarity.

Pilot valve P4, thus actuated, transmits air from the conduit 254 through a conduit 286 to shift the core of the slave valve V4 and thereby raise the piston rod 136 of the slab defrosting cylinder 134. Since the defrosting tank 69 is coupled to the piston rod, the defrosting tank is elevated into surrounding relation with the mould B which is dwelling at the DEFROST STATION D.

With the assumed operational conditions previously outlined, the mould B1 (and the preceding moulds B2, B3, etc. back to the filler 30) does not have any product since it has not yet been filled. In this case, the "empty" extractor pins C1, C2, C3 etc., will be moved through the slab handling mechanism K without any frozen product slabs E. Consequently, from this point on it will be assumed that the moulds upstream of the DEFROST STATION D have already cycled through the machine and, therefore, the moulds contain frozen product slabs E1, E2, E3, and so forth.

The frozen slab E1 (Fig. 12) is now being defrosted. It should be noted that the slab defrosting cylinder 134 cannot raise the defrosting tank 69 unless the slab extracting cylinder 120 has positioned the transfer frame 80 to its lowermost position to actuate the valve P7, and unless the piston rod 31 of the conveyor indexing cylinder 27 is at the end of a driving stroke to actuate the valves P4 and P5. As illustrated by the directional arrow on the twisting yoke 92 (Figs. 11 and 12) the yoke has now been completely turned 180 degrees. When the extractor pin C1 has later moved into the twisting yoke as seen in phantom line in Figure 12, this rotational movement of the twisting yoke releases the slab E1 and the slab drops on to the discharge conveyor DC.

STEP 3 (Figures 13 and 19)

When the defrosting tank 69 is in its uppermost position, the pilot valve P6 is actuated to raise the transfer frame 80 and extract the slab E1 from the mould B1. For this purpose, the pilot valve P6 reverses the air input to the slab extracting cylinder 120 by placing one of its valve passages in communication with the conduit 252 and a conduit 290, thus shifting the core of the slave valve V2 so that air is supplied to the piston end of the slab extracting cylinder 120; the projected piston rod of the cylinder 120 pushes the transfer frame 80 upward, and the thus elevated transfer yoke 68 carries the extractor pin C1 and the frozen slab E1 to the Figure 13 position in which the gripping head 64 of the extractor pin is horizontally aligned with the pusher bar 166 of the pusher frame 160.

As soon as the actuator of the pilot valve P1 is released when the piston rod 122 begins to move out of the slab extracting cylinder 120, the pilot valve P1 bleeds air from the conduit 254 to atmosphere so that the piston

rod 236 of the slab releasing cylinder 238 returns to its retracted position. This causes the twisting yoke 92 to rotate 180 degrees so that the slot 94 is reversed. As seen in phantom, when the extractor pin C1 reaches the twisting yoke 92, the pin will be turned back to its original orientation.

STEP 4 (Figures 14 and 20)

In this step, the pusher frame 160 is moved downstream so that the pusher bar 166 moves the gripping head 64 of the extractor pin C1 out of the transfer yoke 68 and onto the track 170. Also, the defrosting tank 69 is moved down, and the cylinder 27 which drives the main conveyor A is readied for another driving stroke. To this end, the slab extracting cylinder 120 actuates the pilot valve P7 at the end of its stroke, thereby conducting air into a conduit 292. The actuated pilot valve P5 transmits this air through a conduit 294 to shift the core of the slave valve V4 and pressurize the piston end of the slab defrosting cylinder 134 through the conduit 280. This lowers the defrosting tank 69.

Meanwhile, air from the conduit 294 is transmitted through a branch conduit 296 to shift the core of the slave valve V5. This causes the slab index cylinder 190 to be pressurized, and the pinion 180 is rotated clockwise to move the pusher frame 160 downstream a distance equal to the center to center spacing between the moulds B. The gripping head 64 is thus moved downstream by the pusher bar 166. During the above outlined operational steps, a conduit 298 causes shifting of the core of the slave valve V3 so that air pressure is transmitted through a conduit 300 into the conveyor index cylinder 27. This retracts the piston rod 31 for a subsequent driving stroke which will place the mould B1 under its associated extractor C1.

It will be noted that the piston rod 31 of the main conveyor cylinder 27 must be fully projected to actuate the valve P5 before the above steps are effected. This assures that the main conveyor A has previously undergone a full-length indexing motion. If the machine had already operated through several cycles, the gripping head of the extractor pin would have been positioned ahead of the end pushing surface 205 of the pawl 202. Therefore, at the end of the operational step just described, this extractor pin would have been transferred into the twisting yoke 92. For the full line extractor pin C1, this transfer movement occurs after four complete operating cycles, (or for indexing movement of the mould conveyor A) and is illustrated in Figure 11 by the phantom line extractor pin C1 and slab E1 in the twisting yoke 92.

STEP 5 (Figures 15 and 21)

In this step the pusher frame 160 is retracted upstream by the slab indexing cylinder 190 while all other mechanism is at dwell. At the end of the almost completed STEP 4 driving stroke of the slab index cylinder 190 (Fig. 20), the pilot valve P8 is actuated. Valve P8 is connected in a conduit 302 that transmits air from the input line 248 to shift the valve core of the slave valve V5. This places a straight passage of the valve in alignment with the conduit 284 to pressurize the slab indexing cylinder 190 so as to rotate the pinion gear 180 and return the pusher frame 160 to its upstream position. The pawl 202 is cammed upward by the camming surface 206 engaging the gripping head 64 of the extractor pin C1 when the pusher frame 160 is retracted. As now positioned, the frozen slab E1 and its extractor pin C1 are one increment of conveying movement ahead of the mould B1 from which they were removed. After the next and final step, the sequence reverts back to STEP 1 in which the main conveyor A is again indexed. After the mould conveyor A has indexed a total of four times, the extraction pin C1 will be returned to a different mould because the extractor pins and moulds become out of phase after moving beyond the DEFROSTING STATION D.

STEP 6 (Figures 16 and 22)

In this step, the transfer frame 80 is lowered by the slab extracting cylinder 120 to its initial position. When the extractor pin C1 (phantom lines) is positioned in the return yoke 88, it is in the present step returned to the mould conveyor A. When pilot valve P2 is actuated at the completion of the retracting stroke of the piston rod 194, air from inlet conduit 248 is conducted through the conduit 266 and the pilot valve P3 to shift the core of the slave valve V2. This feeds air from the inlet 248 to the conduit 270, thereby retracting the piston rod 122 of the slab extracting cylinder 120 and lowering the transfer frame 80 to its STEP 1 position. With the piston rod 122 fully retracted, the control circuit is in a condition to begin another cycle of operation beginning with STEP 1. The phantom line extractor pin C1 is thus reinserted in a mould B by the transfer frame 80. It is again noted that the extractor pin C1 is actually returned to one of the moulds only at the end of three or more of the six-step movements just described, and that the mould B1 will lag behind the pin C1 because the conveyor is not indexed until STEP 1. Therefore, the full line extractor pin C1 will be returned to the mould at 350 (Fig. 16), following which the conveyor indexes in STEP 1 to place the extractor pin C2 into the transfer yoke 68.

From the preceding description it will be evident that an important feature of the embodiment hereinbefore described is the provision of a free extractor pin at each end of the mould, and means for conjointly

manipulating the extractor pins without any mechanical connection between the pins. This makes possible the interception of the frozen slabs on a takeaway conveyor and the return of the extractor pins to a mould in the same general area of the machine, and with uncomplicated, easily maintained apparatus. Further, the extractor pins circulate with their associated moulds through the washing and sterilizing zones of the machine preceding each filling and freezing of the mould contents. As a result, there is virtually no danger of bacterial contamination of the slabs with only the ordinary and usual sanitary precautions.

WHAT WE CLAIM IS:—

1. A continuous freezing machine comprising upwardly-open moulds extending across an elongate frame, a mould conveyor mounted on said frame for moving said moulds, an extractor pin removably positioned in each lateral end portion of each said mould, said extractor pins having no mechanical bridging connection, means for filling the moulds with a product which is subsequently frozen on to said extractor pins, conjointly operably frozen slab-withdrawal means for individually gripping and elevating said extractor pins to remove successively formed slabs from the mould at a defrost station, slab-release means for operating said pins to release the frozen slab from said pins at a discharge station, pin return means for returning the slab-free extractor pins at a pin return station for movement with the conveyor, and slab-catching means underlying said discharge and pin return stations.

2. A frozen product machine comprising a frame, open-top moulds, conveyor means on said frame for incrementally carrying said moulds through a plurality of processing stations, at least two rotatable extractor pins removably positioned within the space defined by each said mould, means for filling the moulds with material to be frozen into a slab on said extractor pins and subsequently withdrawn from the mould a portion of each of said extractor pins which lies within the mould including a half-round shank having a flat longitudinal face and an oppositely disposed transversely arcuate longitudinal face, said flat face in an unrotated position of said extractor pin being in abutting relation with one inner wall of each said mould so that said arcuate face is eventually freeze-bonded to the product slab and the flat face is substantially coplanar with the adjacent outer surface of the slab, and means for rotating said extractor pin substantially through 180 degrees about an axis coincident with said flat face subsequent to freezing of the product slab and its removal from the mould, said rotation thereby reversing the former orientation of said extractor pin relative to the slab so that the frozen bond is destroyed and the extractor pin surfaces are disposed laterally clear of the slab.

3. A machine according to claim 1 or claim 2 comprising a gripping head on the upper end of each of said extractor pins, a transfer yoke lying in the path of movement of said gripping heads and arranged to receive slidably said gripping heads, and power-actuated means for elevating said transfer yoke in order to remove the extractor pins and the frozen slab from the mould.

4. A machine according to claim 3 as appendant to claim 2 wherein said gripping heads each include parallel upright surfaces straddling the path of movement of said extractor pin, said means for rotating said extractor pins including a twisting yoke arranged to receive slidably the gripping head of each extractor pin, said yoke being provided with driving surfaces closely adjacent said parallel surfaces of said gripping head, and said power-actuated means serving to rotate said twisting yokes through substantially 180 degrees thereby to rotate said extractor pin and free the frozen slab.

5. A machine according to claim 4 wherein said conveyor includes an endless chain at each end of said mould, an attachment link interconnecting the respective chain with the adjacent end of the mould, a locking plate secured to each of said extractor pins below said gripping head, and an upstanding lock stud secured to said attachment link, said locking plate having an aperture arranged to circumscribe said lock stud, when the extractor pin is disposed within the mould.

6. A machine according to any one of claims 2 to 5 comprising a semi-circular disc normal to the lower end of each said extractor pin shanks, said disc having a flat edge coplanar with said flat face of said extractor pin and having an arcuate edge with a larger radius of curvature than that of said arcuate face so that the curved portion of the disc extends inwardly beyond the arcuate face to provide a support ledge arranged to extend into the frozen slab, said flat surface being coincident with the axis of rotation of said extractor pin and said arcuate surface being defined by a radius generated about said axis.

7. A continuous freezing machine including a plurality of open top moulds movable through a brine tank to freeze product in the moulds, two extractor pins removably positioned in each mould, each said extractor pin including a gripping head positioned above the open top of the mould and a shank portion lying within the mould, a vertically reciprocable transfer yoke intermittently positioned in an initial plane of movement of said gripping head, said transfer yoke and

said gripping head being arranged to interlock slidably at a defrosting station for subsequent co-extensive vertical movement of said transfer yoke and said extractor pins, means operative to defrost the frozen bond between a frozen product slab and the mould at a defrosting station, means for moving said transfer yoke upwards to a predetermined plane superposed above said defrosting station with the frozen product engaged with said extractor pins, a horizontally-reciprocable pusher bar movable through driving and return strokes in the elevated plane of said gripping head, and power means for co-extensively moving said pusher bar in a driving stroke in the same downstream direction with each powered movement of said conveyor, said extractor pins and the frozen product bar carried by said extractor pins thereby being ejected downstream from said yoke in vertically aligned and elevated relation with said moulds, and support means for the thus ejected gripping head.

8. A machine according to claim 7 wherein each said extractor pin shank portion is rotatable, said shank portion being half-round in cross-section and provided with a flat side substantially coincident with an interior upright wall surface of the mould, and a semi-circular disc secured to said shank, said disc having a flat edge coplanar with the flat side of said shank and an arcuate edge formed with a radius larger than the radius of said shank and forming a ledge projecting inwardly of the mould beyond the half round surface of the said shank.

9. A machine according to claim 7 comprising an upwardly displaceable gravity-return pawl movable with said pusher bar, said pawl having a surface defining an upright first driving ledge lying in the elevated plane of said gripping head and a forwardly declining camming surface in trailing relation with said ledge, said camming surface being arranged to strike said ejected gripping head upon said return stroke of said pusher bar and upward displacement of said pawl, said driving ledge thus being arranged to lie rear-ward of said gripping head at the termination of said return stroke for gravity return of said pawl to its initial position, and said driving ledge thereby being positioned to advance said gripping head with the next downstream movement of said pusher bar while a second gripping head is ejected from said yoke by said pusher bar.

10. A machine according to claim 9 comprising second and third driving ledges on said pawl each of said ledges having an associated forwardly declining camming surface in trailing relation therewith, all of said driving ledges being spaced apart the length of the driving stroke of said pusher bar, a succession of said gripping heads being arranged for advancement by said driving ledges during the driving strokes of said pusher bar, and a twisting yoke rotatable about a vertical axis, said third driving ledge at the end of the driving stroke of said pusher bar being arranged to slidably position a gripping head previously advanced by said driving ledges into said twisting yoke.

11. A machine according to claim 10 wherein said extractor pin is rotatable, and means is provided for rotating said twisting yoke following termination of said driving stroke, whereby a gripping head positioned in said twisting yoke rotates each said extractor pin to break the frozen bond and release the frozen product slab.

12. A machine according to claim 10 wherein each said extractor pin is rotatable and has a flat longitudinal surface that is arranged to be coplanar, before rotation, with the end surface of a frozen product slab, and an opposed arcuate surface arranged to be freeze-bonded to the slab, and means is provided for rotating said twisting yoke through substantially 180 degrees to break said frozen bond and to remove said arcuate surface from the slab.

13. A machine according to claim 12 comprising a semi-circular disc secured to the lower end of each said extractor pin, said disc having a recti-linear edge coincident with the flat surface of said pin and an arcuate edge of larger radius than the arcuate surface of said pin to form a lateral ledge which extends into the frozen slab before rotation of said extractor pin.

14. A machine according to claim 1 wherein said gripping and elevating means includes on each extractor pin a gripping head positioned above the open top of the mould and a depending rotatable shank portion lying within the mould, said shank portion being half-round in cross-section and having a flat side substantially coincident with an interior upright wall surface of the mould, and a semi-circular disc secured to said shank, said disc having an arcuate edge formed with a radius larger than the radius of said shank and forming a ledge projecting toward the central portion of the mould and lying beyond the half round surface of said shank.

15. A machine according to claim 14 wherein said semi-circular disc is secured in perpendicular relation to said shank, said disc has a flat edge coincident with the longitudinal axis of said shank and lies adjacent an interior wall surface of the mould, and said extractor pin is rotatable through substantially 180 degrees about the longitudinal axis of said shank, the slab thus being removable from the mould by endwise withdrawal of said extractor pin from the mould with the slab supported by said ledge,

and removable from said extractor pin by rotating the pin to remove said disc from the frozen slab.

16. A continuous freezing machine including a frame, an endless intermittently drivable conveyor chain mounted on said frame for movement in a closed path, a plurality of open top elongate moulds carried by the upper run of said conveyor chain sequentially through a filling zone where a liquid product can be supplied to the moulds, a freezing zone where the product in the mould can be frozen into a single elongate slab, a defrosting zone where the frozen bond between the frozen slab and the mould can be thawed, a slab-handling zone where the frozen slab can be removed from the mould, a washing and sterilizing zone where the empty mould can be washed and sterilized for refilling, an extractor pin removably positioned within the end portions of each mould for freeze-bonding into the product in the mould, each of said extractor pins including a gripping head positioned above the open top of the mould, a shank portion arranged to lie within the mould and a disc portion secured to said shank, said shank being half-round in cross-section with a flat side adjacent a wall surface of the mould and an arcuate side embedded in the frozen product slab, said disc having an arcuate edge extending inwardly beyond the arcuate side of said shank and also being arranged to be embedded in the frozen slab, said shank being rotatable about an axis coincident with its flat side, means at said defrosting station for thawing the frozen bond between the mould and the frozen product slab, means at the defrosting station for gripping and elevating said extractor pins with the attached frozen slab, means for incrementally advancing the elevated extractor pins and slab in synchronism with the intermittent movements of said conveyor chain, means for rotating said extractor pins through 180 degrees so that the extractor pins lie wholly outside and release the frozen slab, means for returning the slab-free extractor pins to a mould on the upper run of said conveyor, and means for retaining the extractor pins in said mould while the mould is carried by said conveyor through said washing and sterilizing zone so that each mould is filled and emptied automatically and only sterile parts contact the frozen product slabs.

17. A frozen product machine substantially as hereinbefore described with reference to the accompanying drawings.

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Agents for the Applicants.

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1260536 COMPLETE SPECIFICATION

14 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

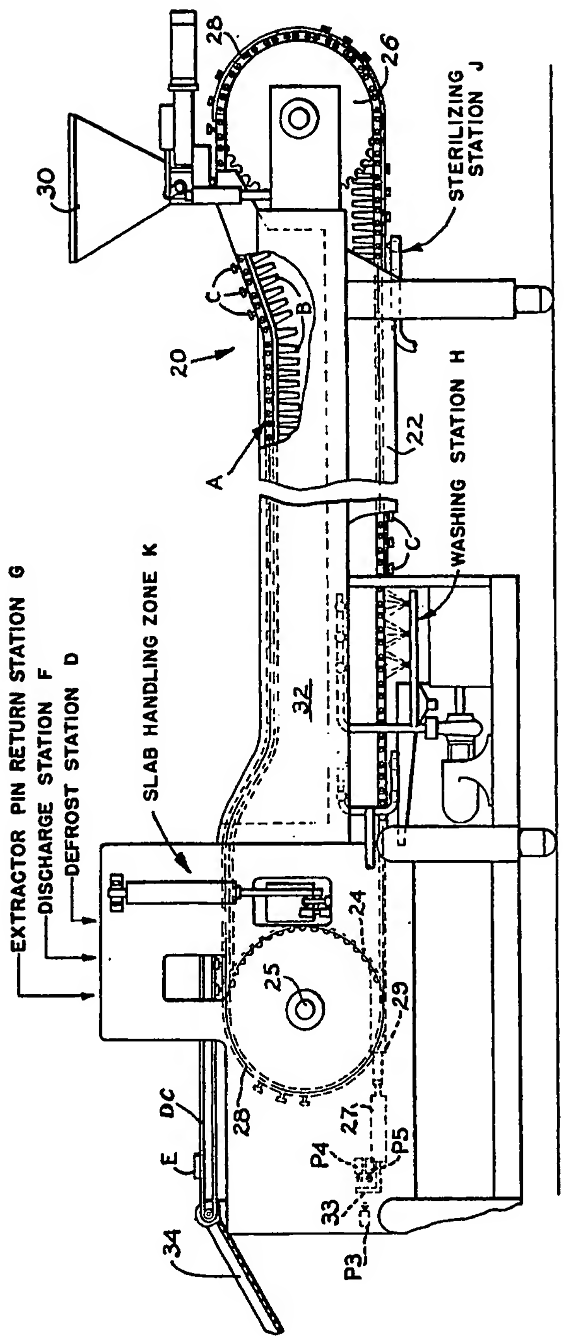


FIG_1

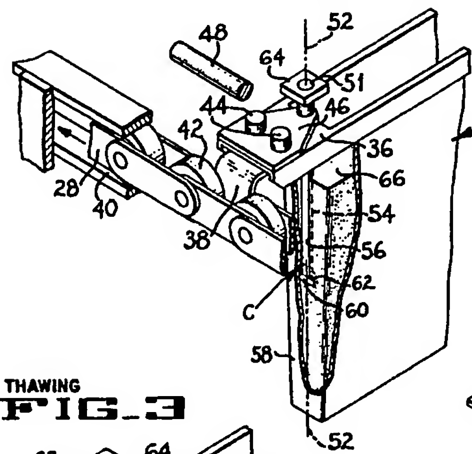
1260536 COMPLETE SPECIFICATION

14 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

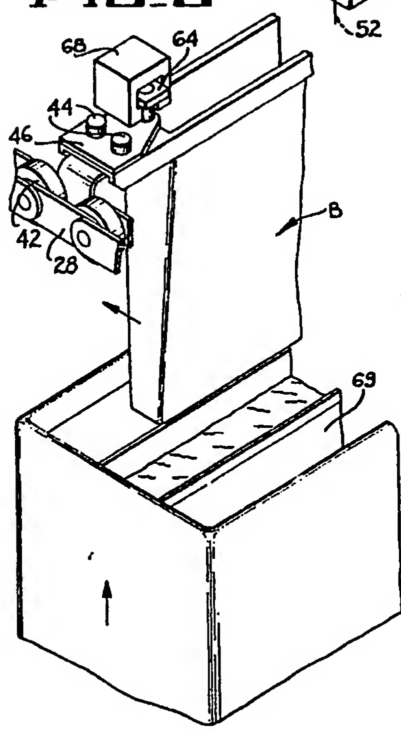
FREEZING

FIG_2



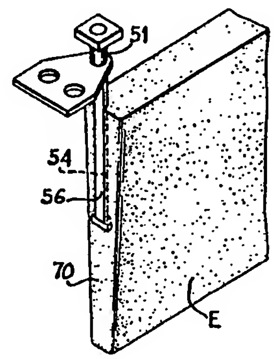
THAWING

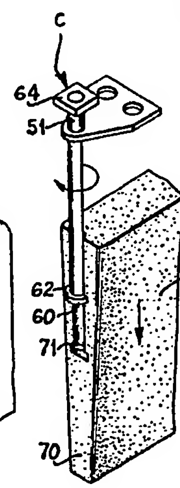
FIG_3



SLAB EXTRACTING

FIG_4

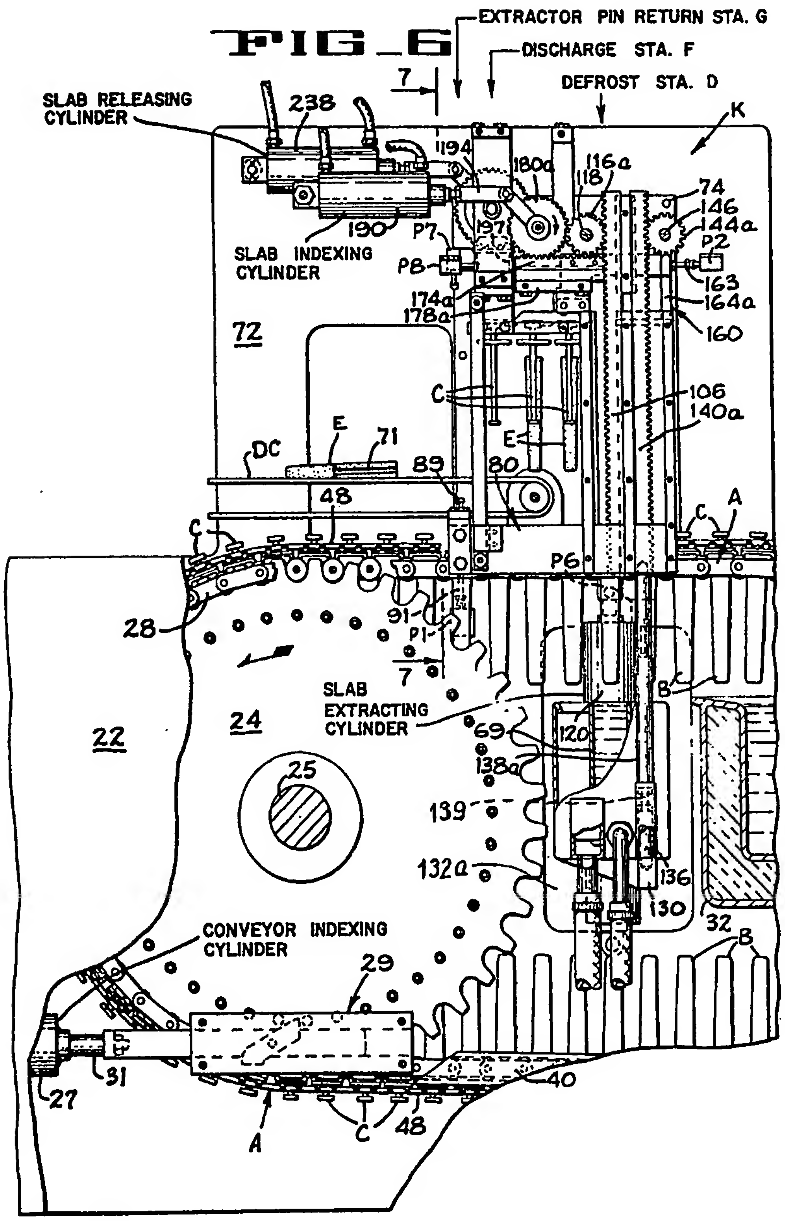




SLAB REMOVAL

FIG_5

FIG_6


EXTRACTOR PIN RETURN STA. G
DISCHARGE STA. F
DEFROST STA. D
SLAB RELEASING CYLINDER
SLAB INDEXING CYLINDER
SLAB EXTRACTING CYLINDER
CONVEYOR INDEXING CYLINDER
238
190
7
K
72
22
24
25
28
29
27
31
40
48
A
B
C
E
DC
71
89
80
91
P1
P6
P7
P8
P2
69
120
138a
139
132a
136
130
32
106
140a
160
164a
163
144a
146
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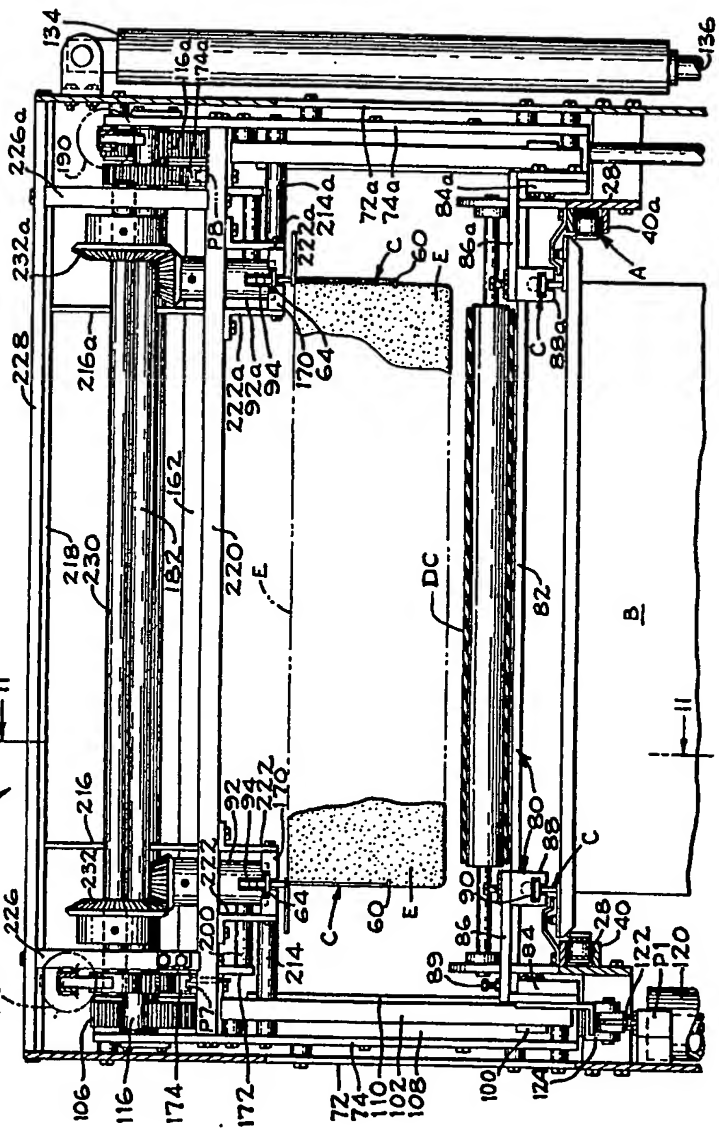
116a
118
180a
197
1194
174a
178a


134
136
116a
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226a
190
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C
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E
222a
214a
PB
222a
92a
94
170
64
C
88a
218
230
182
162
220
E
DC
82
B
11
216
232
226
238
106
116
174
172
72
74
110
102
108
100
124
92
94
222
170
222
200
214
64
C
60
E
89
86
84
90
88
80
C
28
40
122
P1
120
P7
K

FIG_7

FIG_8

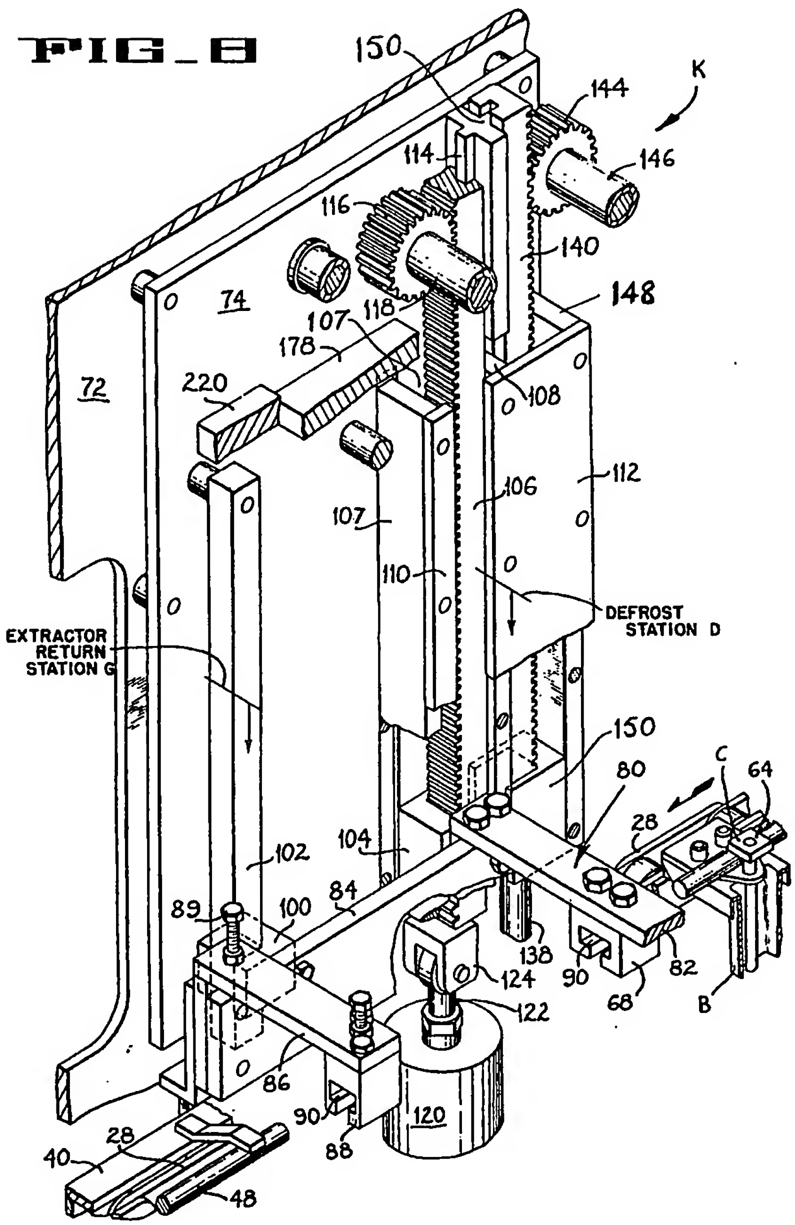
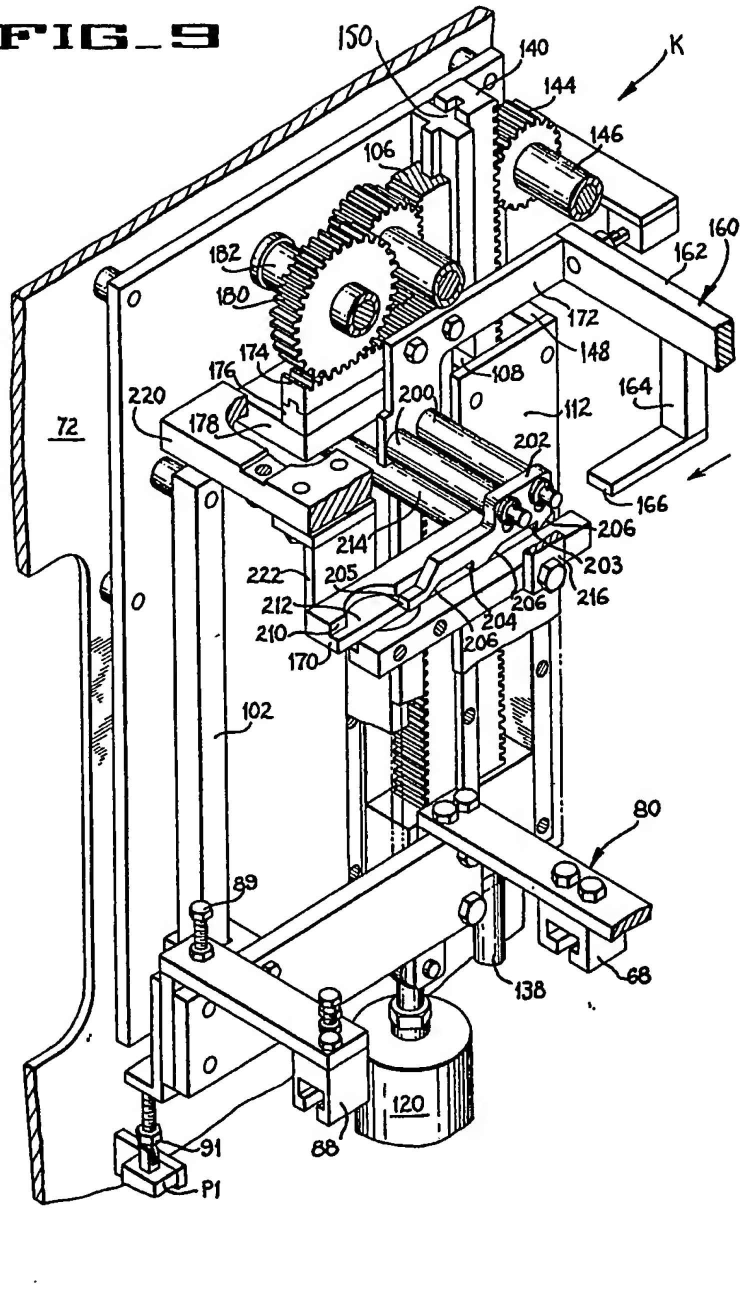

150
144
K
146
114
116
140
148
74
107
118
178
72
220
108
112
106
107
110
DEFROST STATION D
EXTRACTOR RETURN STATION G
150
80
C
64
28
102
104
84
89
100
138
124
90
82
122
68
B
86
120
90
88
28
40
48

FIG_9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148
174
108
176
164
220
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202
166
206
214
203
222
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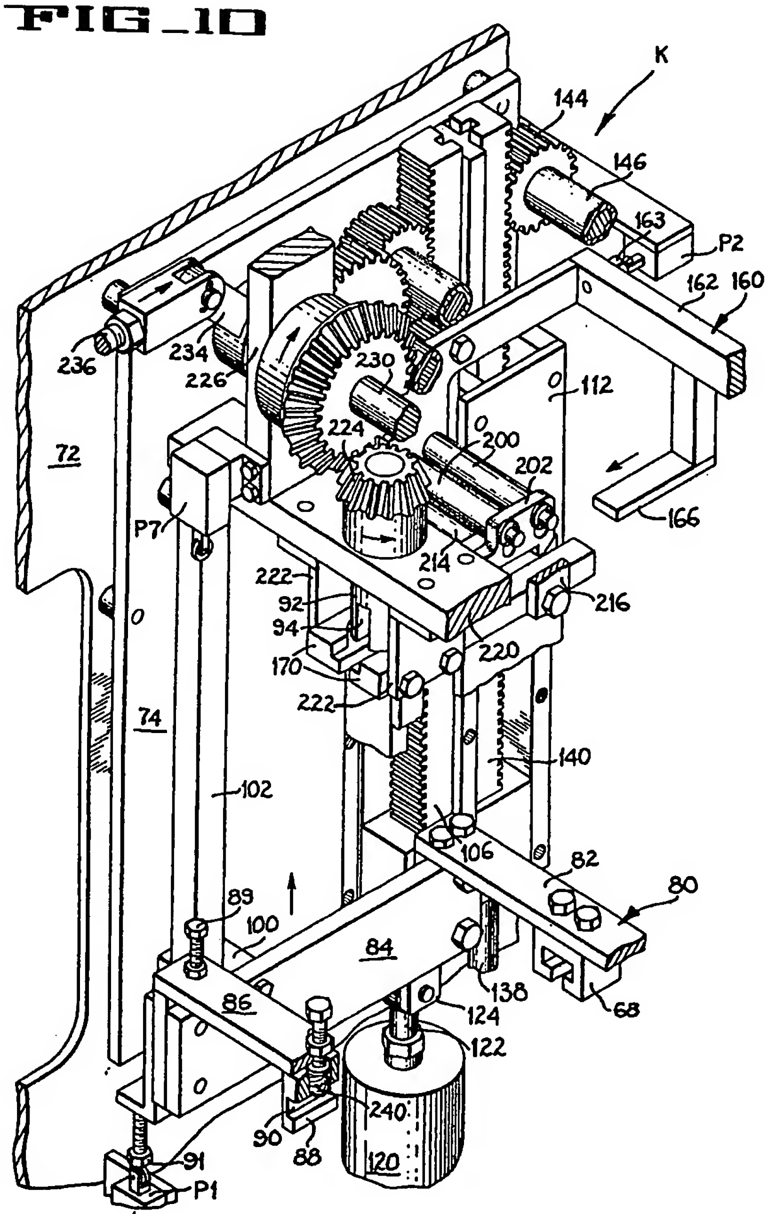
206
204
210
206
170
102
80
89
68
138
120
91
88
P1

FIG_10


K
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P2
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P7
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222
92
216
94
220
170
222
74
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84
86
138
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240
90
88
120
91
P1

FIG_12

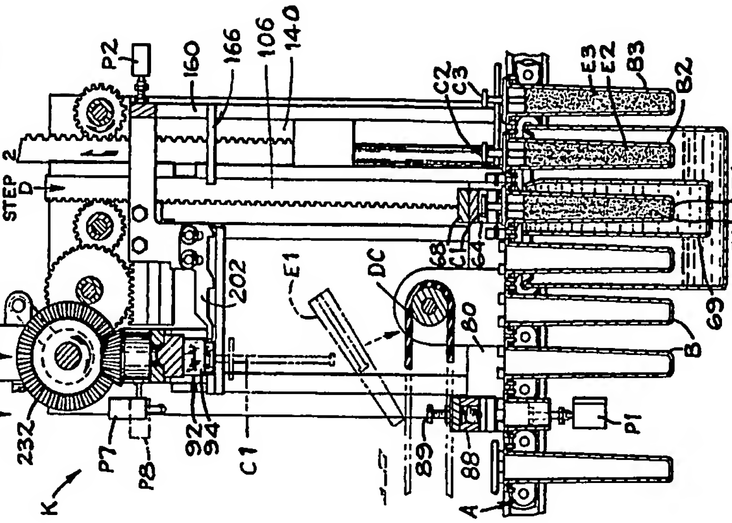
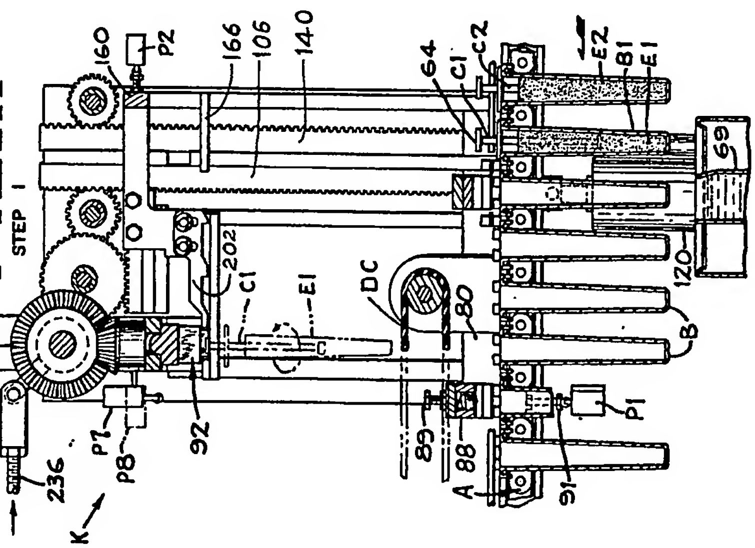

STEP 2
P2
160
166
106
140
C2
C3
E3
E2
B3
B2
B1
E1
69
C1
C4
DC
E1
202
80
B
F
G
232
P7
P8
92
94
C1
89
88
P1
A
K

FIG_11


STEP 1
160
P2
166
106
140
64
C1
C2
E2
B1
E1
69
120
B
202
C1
E1
DC
80
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P7
P8
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91
A
K

FIG_14 STEP 4

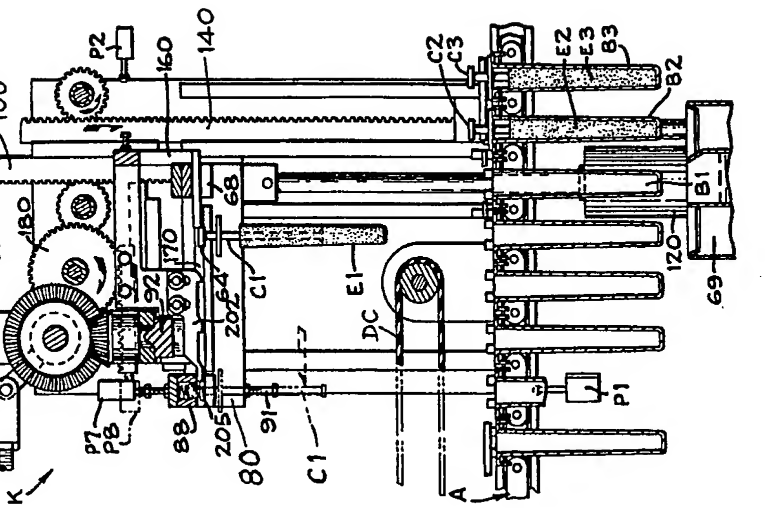
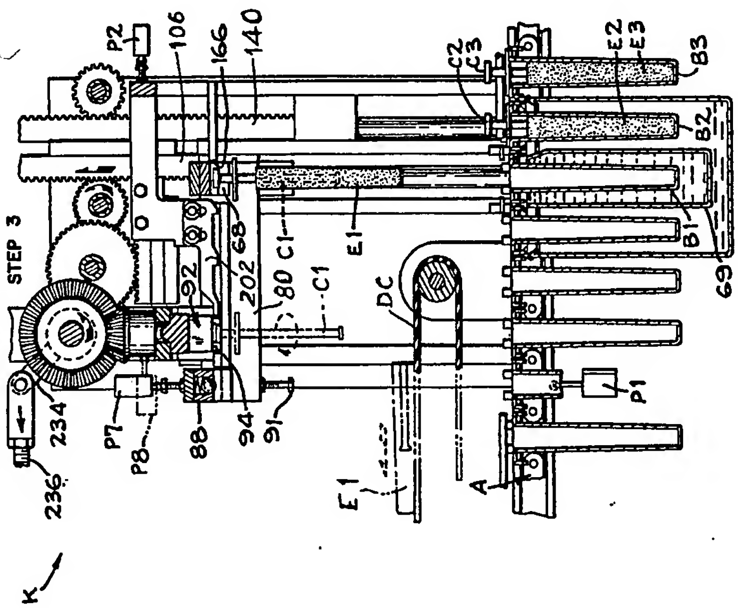


FIG_13 STEP 3



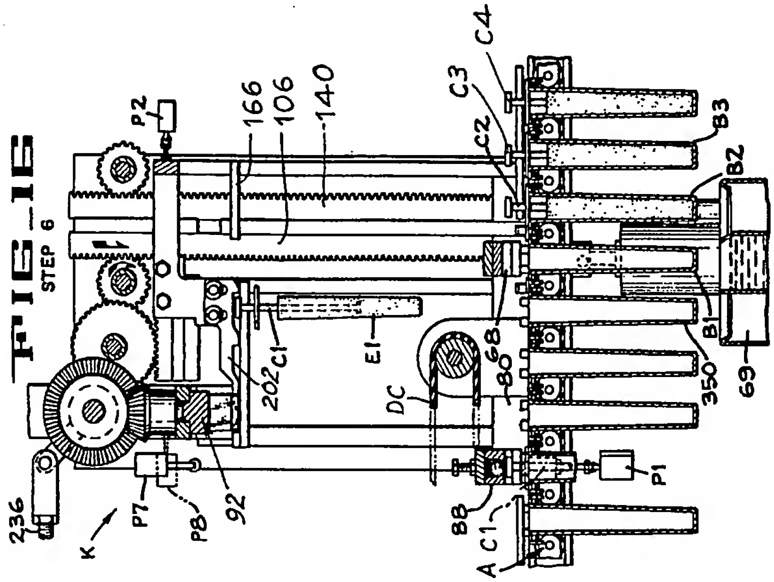


FIG_16
STEP 6

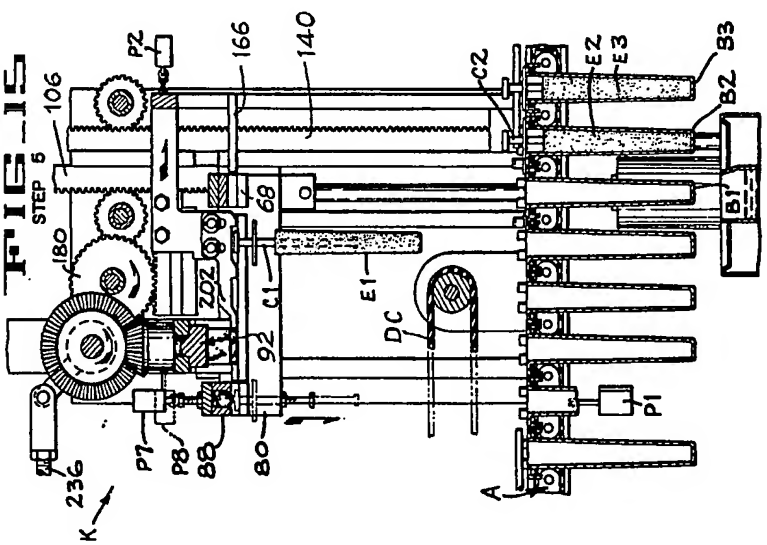


FIG_15
STEP 5

FIG_17 STEP 1

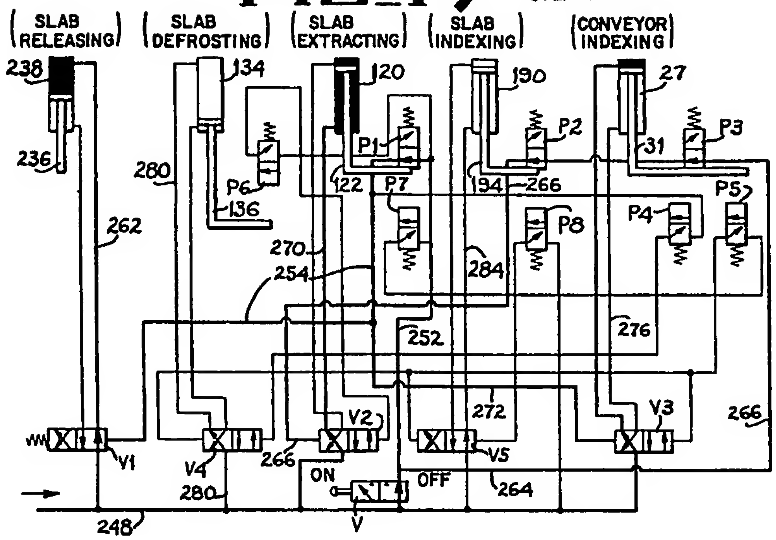


FIG_18 STEP 2

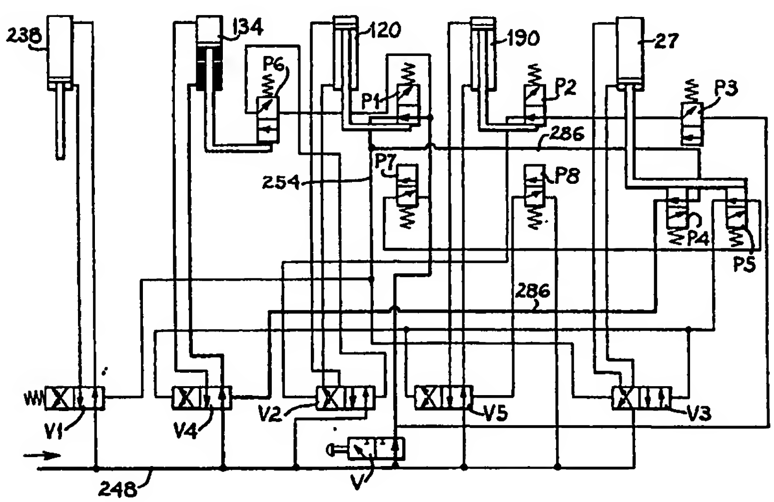


FIG_19 STEP 3

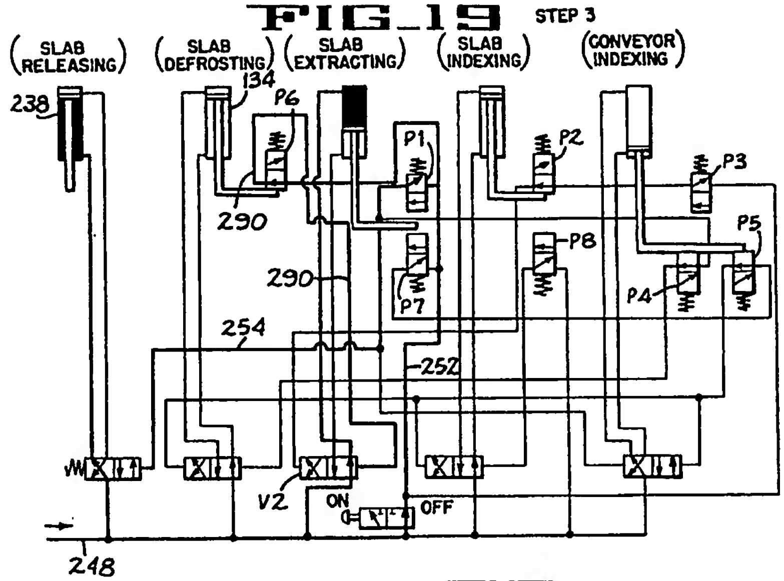


FIG_20 STEP 4

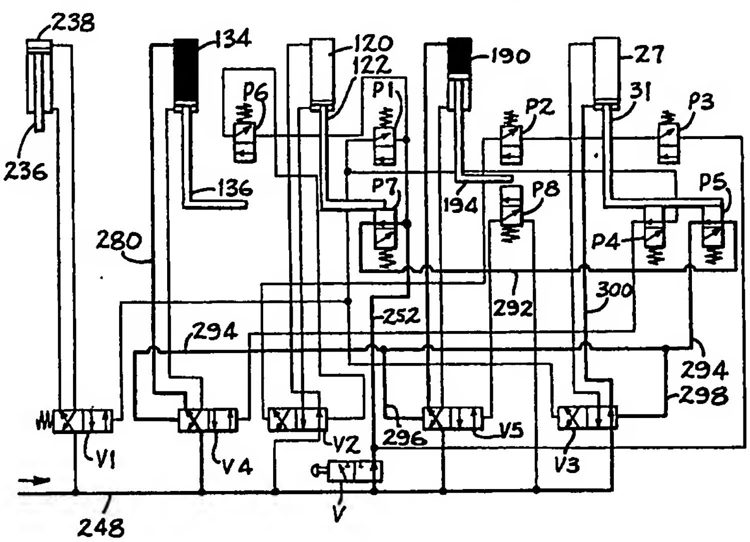


FIG_21 STEP 5

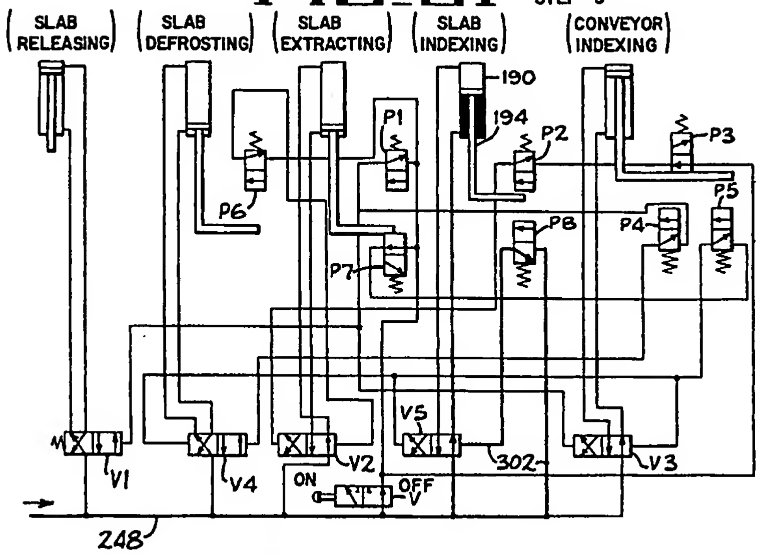


FIG_22 STEP 6

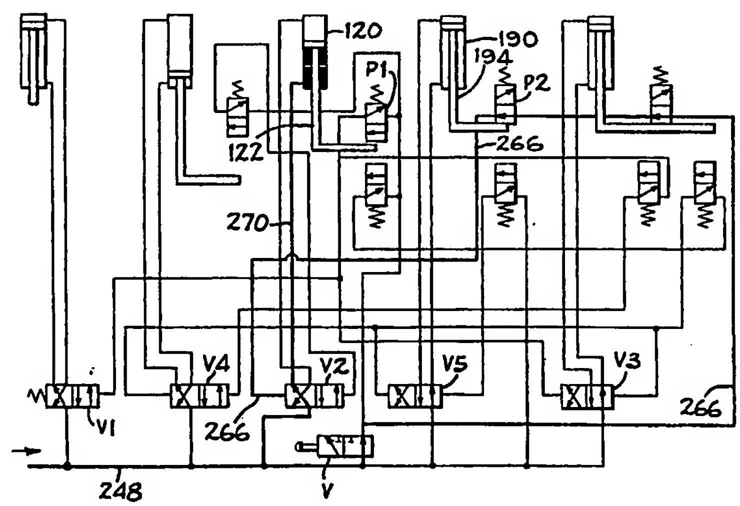
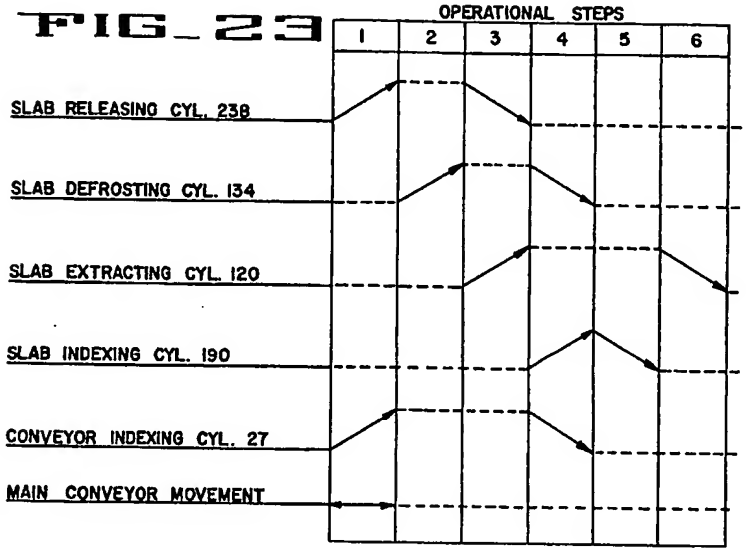


FIG_23



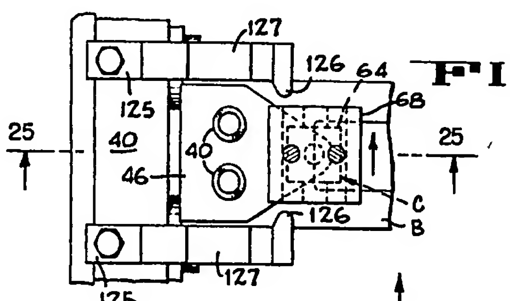


FIG_24

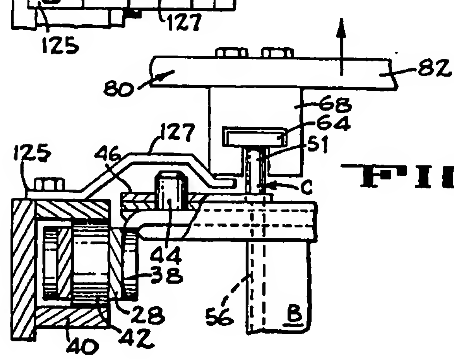


FIG_25

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